



## The Relationship Between Arm Muscle Strength And Leg Muscle Explosive Power And 50-Meter Breast Stroke Swimming Speed

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### ABSTRACT

This study aims to determine the relationship between arm muscle strength and leg muscle explosive power on breaststroke swimming speed. This type of research is correlational research. The population in this study consisted of 2024 Untan Physical Education students, with a sample of 25 male students. The sampling technique used was purposive sampling. The method of obtaining arm muscle strength data used a pull dynamometer test, while leg muscle explosive power was measured using a standing broad jump test. The breaststroke swimming speed test was measured using a stopwatch. Before conducting the correlation analysis, the data were first tested for normality using the Kolmogorov-Smirnov normality test to determine whether the data were normally distributed. The data were then analyzed using product moment correlation (negative correlation) and continued with multiple correlation analysis. The results of the study showed that: 1) There is a significant relationship between arm muscle strength and 50-meter breaststroke swimming speed in 2024 Untan Physical Education students, as evidenced by  $r_{count} \geq r_{table}$  or  $-0.8056 \geq 0.380$ . 2) There is a significant relationship between leg muscle explosive power and 50-meter breaststroke swimming speed in 2024 Untan Physical Education students, as evidenced by  $r_{count} \geq r_{table}$  or  $-0.9054 \geq 0.380$ . 3) There is a significant relationship between arm muscle strength and leg muscle explosive power simultaneously with 50-meter breaststroke swimming speed in 2024 Untan Physical Education students, as evidenced by the calculated  $r$  value of 0.78, which falls into the high or strong correlation category.

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### AUTHORS' CONTRIBUTION

A. Conception and design of the study;  
B. Acquisition of data;  
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## INTRODUCTION

In general, the definition of sport is a physical and psychological activity that is useful for maintaining and improving the quality and health of a person after exercising (A. Ramadhan & Bulqini, 2018). Sport is a human movement activity according to certain techniques in its implementation, there is an element of play and a sense of enjoyment,



done in leisure time and is a healthy and voluntary activity, one of which is swimming. Swimming is a sport that is done in water. Swimming has many benefits and can be said to be a favorite sport for people of all ages (Sanjaya & Rediani, 2022).

There are four swimming styles frequently competed in international and national competitions: butterfly, freestyle, backstroke, and breaststroke. Breaststroke is considered the easiest and most widely practiced. In breaststroke, proper posture must be maintained, with the body parallel to the water's surface. When inhaling, the swimmer must raise their head above the water's surface correctly to properly inhale air, following the technique used. Mastering basic techniques is crucial for improving swimming performance, especially when combined with optimal physical condition.

In the Physical Education, Health, and Recreation Study Program at Tanjungpura University (Untan), students are required to master swimming skills. This skill is not only part of the curriculum but also crucial to supporting their careers in physical education and sports. However, on-the-ground conditions indicate that many students are still unable to optimally integrate swimming technique with explosive muscle strength. This impacts breaststroke speed, particularly in sprint events. In short-distance races like the 50-meter dash, maximum speed is heavily influenced by muscle explosiveness, both in the legs and arms (Khairah et al., 2021).

Arm muscle strength is closely related to a student's breaststroke ability. Arm muscle strength serves as a powerful primary source of propulsion, enabling a faster glide and playing a crucial role in determining swimming speed (Al Rasyid, 2016). This relates to the dynamic strength required to move from the start end of the pool to the finish end. Furthermore, leg muscle strength plays a crucial role in breaststroke swimming. Leg muscle strength is an individual's ability to maximize the potential of their leg muscles in a short period of time (Dinisa Putra & Aziz, n.d.). Leg muscle strength plays a crucial role in breaststroke swimming because it helps balance arm movements. This directly impacts swimming speed. Furthermore, leg muscle strength reflects the muscle's ability to withstand a load for a period of time without fatigue.

Thus, arm and leg muscle strength significantly influences breaststroke speed, as both serve as the primary source of propulsion from the start to the end of the race. Based on this description, it can be concluded that muscle strength is a crucial aspect to consider in improving breaststroke performance, particularly in sprint events. Therefore, based on the aforementioned background, this study aimed to analyze the relationship between arm muscle strength and leg muscle explosiveness on breaststroke speed in Physical Education students enrolled in the 2024 intake.

## **METHODS**

### **Research Design**

This study was conducted using a correlational research design. The correlational method is a statistical method used to compare the measurement results of two different variables in order to determine the level of relationship between those variables

(Zuhri, 2020). Correlational research is classified as non-experimental research that aims to measure, understand, and analyze the statistical relationship between two variables without the influence of other variables. In this study, the independent variable (X1) is arm muscle strength and the independent variable (X2) is leg muscle explosive power, while the dependent variable (Y) observed is breaststroke swimming speed.

This study applied a negative correlation, which is a relationship that occurs when an increase in variable X is followed by a decrease in variable Y, and vice versa. Increased arm muscle strength and leg muscle explosive power indicate an inverse relationship with swimming time, meaning that the greater the strength possessed, the shorter the swimming time achieved. The description of the research data was presented to provide a general overview of the frequency distribution of the data obtained in the study.

### **Population and Sample**

Population is the entire object that is the focus of a study, which can include humans, objects, animals, plants, symptoms, test scores, or certain events that have specific characteristics. (Purwanza et al., 2022 p.43). In this study, the population of Physical Education students class of 2024 amounted to 77 students. This study used purposive sampling as a sampling technique. Purposive sampling is included in the non-probability category, which means it does not provide equal opportunities to all members of the population. This method is applied when sample members are selected specifically according to research criteria. Here are some criteria that must be met: 1) Must be in good health, 2) Active students of Physical Education 2024, 3) Must master the basic techniques of breaststroke swimming. Based on the sampling technique used, the sample in this study is students who meet these criteria totaling 25 students of Physical Education 2024 Untan.

### **Research Instruments**

In this study, the instrument used was a test. The test served as a data collection tool. To measure arm muscle strength, a pull dynamometer test was used, while to measure leg muscle explosiveness, a standing board jump test was used. In this study, the independent variables analyzed were arm muscle strength and leg muscle explosiveness, while the dependent variable was breaststroke speed, measured using the 50-meter breaststroke in 2024 Physical Education students.

### **Data analysis**

After the test instruments were administered, the raw data obtained were processed into normative data. Before conducting the correlation analysis, the data were first tested for normality using the Kolmogorov-Smirnov test to determine whether the data were normally distributed or not. After the data were declared normal, the data obtained from the tests were analyzed using the product-moment correlation test to determine the relationship between arm muscle strength and leg muscle explosive power. After obtaining the product-moment results, a multiple correlation test was then conducted to determine the extent of the relationship.

## RESULTS AND DISCUSSION

### Result

This study used a negative correlation, which is a relationship that occurs when the value of variable X increases while the value of variable Y decreases, or vice versa. Increases in arm muscle strength and leg muscle explosiveness show an inverse relationship with swimming time, where the greater the strength possessed, the faster the time achieved. The description of the research data aims to provide a general overview of the distribution of frequency distribution.

### Normality Test Data

The normality test was conducted to determine whether the research data were normally distributed or not. In this study, the normality test used the Kolmogorov-Smirnov method on the variables of arm muscle strength (Pull Dynamometer), leg muscle explosive power (Standing Broad Jump), and 50-meter breaststroke swimming speed. The data were considered normally distributed if the significance value (Sig.) was greater than 0.05. The results of the normality test can be seen in the following table.

**Table 1.**  
Normality Test Data

Variabel	N	Statistik	Sig. (p-value)	Keterangan
Pull Dynamometer	25	0,156	0,116	Normal
Standing Broad Jump	25	0,128	0,200	Normal
Kecepatan 50 M	25	0,141	0,196	Normal

Based on the results of the normality test using the Kolmogorov-Smirnov method, all research variables obtained significance (Sig.) values greater than 0.05, indicating that the data were normally distributed. The Pull Dynamometer variable obtained a Kolmogorov-Smirnov statistic value of 0.156 with a significance value of 0.116. The Standing Broad Jump variable obtained a statistic value of 0.128 with a significance value of 0.200. Meanwhile, the 50-meter swimming speed variable obtained a statistic value of 0.141 with a significance value of 0.196. Therefore, it can be concluded that all research data met the assumption of normality and were appropriate for further statistical analysis.

### Frequency Distribution of Arm Muscle Strength Test

The results obtained using a pull dynamometer test aimed to measure arm muscle explosive power, where the lowest t-score was 33 kg and the highest t-score was 44 kg. When displayed in the form of a frequency distribution, the arm muscle strength of 2024 Physical Education Students is presented in Table 1 as follows:

**Table 2.**  
Frequency Distribution of Arm Muscle Strength Test

No	Category	Normality	Interval	Absolut Frequency	Relative Frequency
1	Very Good	> 44.00kg	> 44	1	4%
2	Good	35 - 43.00kg	35-43	16	64%
3	Average	26.00 - 35.00kg	26<35	8	32%
4	Poor	18.00 - 26.00kg	18-26	0	0%
5	Very Poor	Sd < 18.00	< 18.00	0	0%
<b>Total</b>				<b>25</b>	<b>100%</b>

Based on Table 1, it can be seen that arm muscle strength in Physical Education students is classified into five categories. In the very good category with a range of  $\geq 44$  kg, there is 1 person (4%). In the good category with a range of 35–43 kg, there are 16 people (64%). Furthermore, in the moderate category with a range of 26–35 kg, there are 8 people (32%). Meanwhile, in the poor category with a range of 18–26 kg and the very poor category with a range of  $< 18$  kg, no students were found in either category.

### Frequency Distribution of Leg Muscle Explosive Power Test

The results of measurements conducted through a standing broad jump test to assess the explosive power of the leg muscles of 25 Physical Education students from the class of 2024 showed that the lowest value was 2.15 m and the highest value was 2.64 m. When presented in the form of a frequency distribution, the explosive power data for the leg muscles of the Physical Education students from the class of 2024 can be seen in Table 2 below:

**Table 3.**

Frequency Distribution of Leg Muscle Explosive Power Test

No	Category	Normality	Interval	Absolut Frequency	Relative Frequency
1	Very Good	$> 2,44$ m	$> 2,44 - 2,64$	10	10
2	Good	2,44 - 2,29 m	2,29 - 2,44	12	12
3	Average	2,28 - 2,16 m	2,16 - 2,28	2	2
4	Poor	2,15 - 1,98 m	1,98 - 2,15	1	1
5	Very Poor	$< 1,98$ m	$< 1,98$	0	0
<b>Total</b>				<b>25</b>	<b>100%</b>

Based on Table 2, it can be seen that the explosive power of the leg muscles of Physical Education students of the class of 2024 is classified into five categories. In the very good category with a range of 2.45–2.64 m, there are 10 students (40%). In the good category with a range of 2.29–2.44 m, there are 12 students (48%). Furthermore, in the moderate category with a range of 2.16–2.28 m, there are 2 students (8%). In the poor category with a range of 1.98–2.15 m, there is 1 student (4%). Meanwhile, in the very poor category with a range of  $< 1.98$  m, there are no students found.

### Frequency Distribution of 50 Meter Breaststroke Swimming Test

The measurement results carried out through a 50-meter breaststroke swimming speed test using a stopwatch aimed to determine the travel time of Physical Education students from the class of 2024. From these results, the lowest value was obtained at 57.48 seconds and the highest value was in the range of 40.01–40.10 seconds. When presented in the form of a frequency distribution, the 50-meter breaststroke swimming speed data for Physical Education students from the class of 2024 can be seen in Table 3 below.

**Table 4.**

Frequency Distribution of Swimming Tests

No	Category	Normality	Interval	Absolut Frequency	Relative Frequency
1	Very Good	$> 2,44$ m	$> 2,44 - 2,64$	10	10
2	Good	2,44 - 2,29 m	2,29 - 2,44	12	12
3	Average	2,28 - 2,16 m	2,16 - 2,28	2	2
4	Poor	2,15 - 1,98 m	1,98 - 2,15	1	1
5	Very Poor	$< 1,98$ m	$< 1,98$	0	0
<b>Total</b>				<b>25</b>	<b>100%</b>

Based on Table 3, it can be seen that the 50-meter breaststroke swimming speed of Physical Education students of the class of 2024 is classified into five categories. In the excellent category with a range of 40.01–40.10 seconds, there is 1 person (4%). In the good category with a range of 40.15–45.91 seconds, there are 10 people (40%). Furthermore, in the moderate category with a range of 45.92–51.66 seconds, there are 7 people (28%). In the poor category with a range of 51.72–57.42 seconds, there are 2 people (8%). Meanwhile, in the very poor category with a range of 57.48–60 seconds, there are 5 people (20%).

After calculations are performed to determine the interval class level for each type of test, the results of the inter-variable significance test are presented, which aims to determine the strength or weakness of the relationship between the variables studied. This relationship can be seen in the following explanation.

**Results of the Significance Test of the Relationship between Arm Muscle Strength (X1) and 50-meter Breaststroke Swimming Speed (Y)**

**Table 5.**

Results of the Significance Test of the Relationship between X1 and Y

	X1	Y	X1 <sup>2</sup>	Y <sup>2</sup>	XY
<b>Total</b>	902	1223,78	32718	71887,17	43364,13

$$r = \frac{n - (\sum x) (\sum y)}{\sqrt{[n \sum X^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]}}$$

$$r = \frac{25 - (43365,13) - (902)(1223,78)}{\sqrt{[25 \sum 32718 - (902)^2][25 \sum 71887,17 - (1223,78)^2]}}$$

$$r = \frac{-19,72}{24476,655}$$

$$r = 0,8056$$

Based on the results of calculations using the product moment correlation formula (negative correlation) that have been carried out. It is known that there are results with a correlation coefficient value (r<sub>x<sub>1</sub>y</sub>) = - 0.8056, or called r count = - 0.8056, while r table with a significance of 5% is -0.380. Thus, from the data it can be said that r count ≥ r table or - 0.8056 ≥ 0.380. So it can be explained that there is a significant relationship between arm muscle strength (X1) and breaststroke swimming speed (Y) in Physical Education students class of 2024

**Results of the Significance Test of the Relationship between Leg Muscle Explosive Power (X2) and 50-meter Breaststroke Swimming Speed (Y)**

**Table 6.**

Results of the Significance Test of the Relationship between X2 and Y

	X2	Y	X2 <sup>2</sup>	Y <sup>2</sup>	XY
<b>Total</b>	66,3	1223,78	51231	71887,17	3129,7355

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

$$r = \frac{25(3129,7355) - (66,3)(1223,78)}{\sqrt{[25\sum 51321 - 66,3]^2[25\sum 71887,17 - (1223,78)^2]}}$$

$$r = \frac{-2893,227}{\sqrt{319,530}}$$

$$r = 0,9054$$

Based on the results of calculations using the product moment correlation formula (negative correlation) that have been carried out. It is known that there are results with a correlation coefficient value  $(r_{xy}) = -0.9054$  or called  $r_{count} = -0.9054$ , while  $r_{table}$  with a significance of 5% is 0.380. Thus, from the data it can be said that  $r_{count} \geq r_{table}$  or  $-0.9054 \geq 0.380$ . So it can be explained that there is a significant relationship between the explosive power of the leg muscles (X2) and the speed of breaststroke swimming (Y). In Physical Education students class of 2024.

**Results of the Significance Test of the Relationship between Arm Muscle Strength (X1) and Leg Muscle Explosive Power (X2)**

**Table 7.**

Results of the Significance Test of the Relationship between X1 and X2

	X1	X2	X <sup>1</sup>	X <sup>2</sup>	X1X2
<b>Total</b>	902	66,3	32718	51231	2.216,51

$$r = \frac{(n\sum X1X2) - (n\sum X1)(n\sum X2)}{\sqrt{(n(\sum X1^2) - (\sum X1)^2)\{n(\sum X2^2) - (\sum X2)^2\}}}$$

$$r = \frac{25(2216,51) - (902)(66,3)}{\sqrt{25(32718)^2 - (902)^2}\{25(51231)^2 - (66,3)^2\}}$$

$$r = \frac{-4943,249}{6854,704}$$

$$r = -0,7211$$

Based on the results of calculations using the multiple correlation formula that have been carried out, it is known that there is a result with a correlation coefficient value  $(r_{X1X2}) = -0.7211$  or called  $r_{count} = -0.7211$ .

**Results of the Significance Test of the Relationship between Arm Muscle Strength (X1) and Leg Muscle Explosive Power (X2) and 50 Meter Breaststroke Swimming Speed (Y)**

$$r_{yx1x2} = \frac{\sqrt{r^2_{yxL} + r^2_{yx^2} - 2r_{yx1}r_{yx^2}r_{x1x2}}}{1 - r^2_{x1x2}}$$

$$r_{yx1x2} = \frac{\sqrt{-(8056)^2 + (-0,9054)^2 - (2(-0,8056)(-0,9054)(0,7211))}}{1 - (-0,7211)^2}$$

$$r_{yx1x2} = \sqrt{0,612}$$

$$r_{yx1x2} = 0,7823$$

Based on the results of calculations using the multiple correlation formula that have been carried out, it is known that there is a result with a correlation coefficient value ( $r_{y_1x_2}$ ) = 0.78 or called calculated  $r = 0.78$ .

## Discussion

Based on data analysis, there is a significant relationship between arm muscle strength and leg muscle explosive power on the 50-meter breaststroke swimming speed in Tanjungpura University Physical Education students class of 2024. The results of this study are supported by Al Rasyid (2016), who stated that arm muscle strength functions as a major generator of propulsion, faster glide movement, and a determinant of swimming speed. This is also reinforced by Sugiarto et al. (2023), who explained that arm muscle strength reflects the swimmer's ability to maintain effective arm performance while in the water. Therefore, good arm muscle strength will affect an athlete's swimming speed. Athletes with stronger arm muscles are able to maintain forward propulsion effectively and sustain movement efficiency in the water. In line with this, Nursalam & Aziz (2020) stated that arm muscle strength contributed 46.10% to the 100-meter breaststroke swimming speed. Furthermore, Marza et al. (2020) found a 33% contribution between arm muscle strength and 200-meter breaststroke swimming speed using the push-up test as a measuring tool. Each individual has different arm strength capacities, ranging from strong to low arm muscle strength (Sundari & Sukadiyanto, 2019). Based on the opinions of the experts above, arm muscle strength plays a crucial role in creating a regular and measurable pull throughout each movement cycle. With powerful arm muscles, swimmers can maintain a balanced stroke rhythm, reduce speed loss during the glide phase, and maintain a stable body position. Therefore, breaststroke speed becomes more consistent, especially during long-distance swimming.

From a biomechanical perspective, arm muscle strength contributes significantly to the propulsion phase of breaststroke swimming. During the pull movement, swimmers must apply force efficiently against water resistance to generate forward motion. According to Maglischo (2003), effective swimming performance depends on the swimmer's ability to maximize propulsive force while minimizing drag force. Strong arm muscles help swimmers maintain an optimal elbow angle and pulling trajectory, which are important for increasing propulsion efficiency and reducing unnecessary lateral movement. In addition, biomechanical studies by Barbosa et al. (2010) explained that swimming speed is highly influenced by stroke efficiency, coordination, and body alignment in the water. Swimmers with greater arm strength tend to maintain better streamline positions during the glide phase, thereby reducing hydrodynamic resistance and preserving velocity. Thus, arm muscle strength does not only contribute physically but also biomechanically through efficient movement mechanics and energy transfer.

Swimming speed is influenced by arm muscle strength and leg muscle explosiveness, supported by Sugiarto (2023), who stated that arm muscle strength and leg muscle explosiveness have a close relationship with 50-meter breaststroke speed. Based on the results of data analysis, a significance value of  $0.000 < 0.05$  indicates a

relationship between arm muscle strength and leg muscle explosiveness with breaststroke swimming speed. This means that the better the arm muscle strength and leg muscle explosiveness of athletes, the better their swimming speed performance. This finding is reinforced by Khairoh et al. (2021), who stated that leg muscle explosive power and arm muscle strength are simultaneously related to 50-meter breaststroke speed. Similarly, Panji Sukma Kristiaputra & Sugiarto (2023), in their study entitled "The Relationship Between Arm Muscle Strength and Leg Muscle Explosive Power on the Breaststroke Swimming Speed of Oasis Swimming Club Athletes," found a significant relationship with a significance value of  $0.000 < 0.05$ .

Leg muscle explosive power is also a crucial component in breaststroke biomechanics because the frog kick movement is the primary source of propulsion. According to Seifert et al. (2010), coordination between upper and lower limb movements greatly affects swimming efficiency and velocity continuity during stroke cycles. Biomechanically, the breaststroke kick involves simultaneous extension at the hip, knee, and ankle joints, requiring explosive muscular contractions to produce maximal thrust in a short period of time. Swimmers with high leg explosive power are able to generate stronger propulsion and accelerate more effectively after the glide phase. Furthermore, Sanders et al. (2005) emphasized that timing and synchronization between arm pull, breathing, glide, and leg kick are essential in minimizing deceleration during the stroke cycle. If coordination is poor, swimmers may experience increased drag force and reduced propulsion efficiency, ultimately decreasing swimming speed. Therefore, breaststroke performance is determined not only by physical strength but also by biomechanical efficiency involving body alignment, movement synchronization, propulsion mechanics, and drag reduction strategies.

The discussion in this study has sufficiently linked the findings with previous studies; however, the analysis remains largely descriptive and has not fully explored the biomechanical aspects of breaststroke swimming movements critically. In addition, the references used are still dominated by national sources, while international biomechanical studies related to swimming performance remain limited. Therefore, integrating broader international perspectives is important to strengthen the theoretical foundation and provide a deeper understanding of the interaction between muscle strength, propulsion efficiency, stroke coordination, and hydrodynamic principles in breaststroke swimming performance.

## CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that there is a significant negative relationship between arm muscle strength and 50-meter breaststroke swimming speed in Physical Education students of Tanjungpura University class of 2024. In addition, a significant negative relationship was also found between leg muscle explosive power and 50-meter breaststroke swimming speed in Physical Education students of that class. Overall, the results of the study also show a

significant correlation between arm muscle strength and leg muscle explosive power together on 50-meter breaststroke swimming speed in Physical Education students of Tanjungpura University class of 2024.

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